ELECTROMAGNETIC VALVE UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates in general to electromagnetic valves and more particularly to the electromagnetic valves of an integrated type that has a plurality of electromagnetic valves integrally installed therein.

2. Description of the Related Art

Hitherto, various electromagnetic valve units have been proposed and put into practical use, particularly in the field of wheeled motor vehicles. One of them is shown in Japanese Utility Model Provisional Publication (Jikkaihei) 6-32863.

For clarifying the task of the invention, the electromagnetic valve unit disclosed in the publication will be briefly described.

The electromagnetic valve unit of the publication comprises generally a rectangular parallelepiped yoke and a pair of electromagnetic valves installed in the yoke. That is, respective solenoid coils of the two electromagnetic valves are installed abreast in the yoke, and the yoke has two through openings for mounting therein respective valve function parts of the two valves. When each solenoid coil is energized, a magnetic flux is generated using a part of the yoke as an outside magnetic path. Each solenoid coil has terminal members projected sideward therefrom and upon assembly, the terminal members are projected outward through openings that are formed in a longitudinal end of the yoke.

Usually, in an antilock brake system of wheeled motor vehicles, a plurality of electromagnetic valves are installed in a common block together with a control board, an electric motor, a fluid pump and their associated parts. Nowadays, to achieve a compact construction of the block, there has been proposed a layout wherein the control board is placed directly on the abreast

arranged electromagnetic valves.

SUMMARY OF THE INVENTION

However, if such layout is practically employed with the above-mentioned known electromagnetic valve unit, electric connection between the valve unit and the control board would need inevitably a longer wiring because the terminal members of each solenoid coil are projected outward from the openings formed in the longitudinal end of the yoke, that is, from the openings that are positioned away from the control board. If, for shortening the wiring, the openings of the yoke through which the terminal members are projected outward are provided in an upper wall of the yoke that is positioned just below the control board, the work for assembling the solenoid coils to the yoke becomes difficult or at least troublesome.

It is therefore an object of the present invention to provide an electromagnetic valve unit that is free of the above-mentioned drawbacks.

According to the present invention, there is provided an electromagnetic valve unit which comprises a plurality of solenoid coils which are abreast installed in a common yoke having their connection terminals projected in the same direction, that is, toward a control board that is to be directly mounted on the yoke.

According to a first aspect of the present invention, there is provided an electromagnetic valve unit which comprises a yoke of magnetic metal, the yoke including upper and lower walls that are integrally connected by side walls; a slit provided by the upper wall of the yoke, the slit extending along a longitudinal axis of the yoke between axially opposed ends of the yoke; and a plurality of electromagnetic valves abreast installed in the yoke in such a manner that the yoke constitutes outside magnetic paths of solenoid coils of the valves, each solenoid coil having terminal members projected outward from the yoke

through the slit.

According to a second aspect of the present invention, there is provided an electromagnetic valve unit which comprises a yoke of magnetic metal, the yoke including upper and lower walls that are integrally connected by side walls; a slit provided by the upper wall of the yoke, the slit extending along a longitudinal axis of the yoke between axially opposed ends of the yoke; and a plurality of electromagnetic valves abreast installed in the yoke in such a manner that the yoke constitutes outside magnetic paths of solenoid coils of the valves, each solenoid coil having terminal members projected outward from the yoke through the slit, wherein the solenoid coils of the electromagnetic valves are arranged along the longitudinal axis forming a given number of pairs of the coils along the same.

According to a third aspect of the present invention, there is provided an antilock brake system for a wheeled motor vehicle, which comprises a fluid line extending between a master cylinder of a brake pedal and brake cylinders of road wheels; and an electromagnetic valve unit arranged in the fluid line to selectively establish open and close the passage of the fluid line, the electromagnetic valve unit comprising a yoke of magnetic metal, the yoke including upper and lower walls that are integrally connected by side walls; a slit provided by the upper wall of the yoke, the slit extending along a longitudinal axis of the yoke between axially opposed ends of the yoke; and a plurality of electromagnetic valves abreast installed in the yoke in such a manner that the yoke constitutes outside magnetic paths of solenoid coils of the valves, each solenoid coil having terminal members projected outward from the yoke through the slit.

BRIEF DESCRIPTION OF THE DRAWIGNS

Other objects and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective view of an electromagnetic valve unit which is a first embodiment of the present invention;

Fig. 2 is an enlarged sectional view of the electromagnetic valve unit of the first embodiment;

Fig. 3 is a front perspective view of a common yoke used in the electromagnetic valve unit of the first embodiment;

Fig. 4 is a back perspective view of the common yoke of Fig. 3;

Fig. 5 is an exploded view of the electromagnetic valve unit of the first embodiment;

Fig. 6 is a front perspective view of a common yoke used in an electromagnetic valve unit of a second embodiment of the present invention;

Fig. 7 is a back perspective view of the common yoke of Fig. 6;

Fig. 8 is an exploded view of the electromagnetic valve unit of the second embodiment; and

Fig. 9 is a schematic view of an automotive antilock brake system to which an electromagnetic valve unit of the present invention is practically applied.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In the following, two embodiments 100 and 200 of the present invention will be described in detail with reference to the accompanying drawings.

For ease of description, various directional terms, such as, right, left, upper, lower, rightward and the like are used in the following description. However, such terms are to be understood with respect to only drawing or drawings on which the corresponding part or portion is shown.

Referring to Figs. 1 to 5, particularly Figs. 1 and 5, there is shown an electromagnetic valve unit 100 that is the first embodiment of the present invention.

Electromagnetic valve unit 100 shown by the drawings is of

a type that is installed in an automotive antilock brake system for controlling opening/closing of a fluid passage of the system. That is, the unit 100 is integrally installed in a block together with a control board, an electric motor, a fluid pump and their associated parts. Although not shown in the drawings, the control board is placed directly above electromagnetic valve unit 100.

As is best seen from Fig. 5, in this first embodiment 100, eight electromagnetic valves 2 are installed in a common yoke 3. More specifically, four pairs of electromagnetic valves 2 are abreast arranged in common yoke 3 in order.

Fig. 2 shows in a sectional manner the paired valves 2. Although these paired valves 2 have a slight difference in construction, their basic structures are generally the same. However, the left valve 2 is of a normally closed type and the right valve 2 is of a normally open type.

Each electromagnetic valve 2 generally comprises, in addition to the common yoke 3, a solenoid coil 4 and a valve function part 5, as main components. Solenoid coil 4 comprises a plastic bobbin 6 and a winding 7 disposed around bobbin 6.

As is understood from Figs. 2 and 5, both terminal ends of each winding 7 are connected to respective terminal pins 8 and 8 that are embedded in a rectangular projection 30 provided by bobbin 6. That is, each bobbin 6 has at an upper part the rectangular projection 30 through which two terminal pins 8 and 8 are projected upward.

It is to be noted that the terminal pins 8 and 8 are projected axially outward with respect to the corresponding solenoid coil 4.

As is seen from Fig. 2, valve function part 5 comprises a tubular valve body 9 and an armature 10 axially movably received in valve body 9. A lower end of armature 10 is equipped with a valve member 11 that is capable of closing a

passage defined by a valve seat 12. That is, when armature 10 is moved upward, valve member 11 opens the passage and when armature 10 is moved downward, valve member 11 closes the passage.

Tubular valve body 9 is tightly and concentrically received in a center bore of bobbin 6 of solenoid coil 4 and has a thicker lower portion 9a that is snugly put in a bore 14 formed in a metal housing 13 of the antilock brake system (ABS). Preferably, housing 13 is made of aluminum or the like.

Housing 13 is formed with first and second ports 15 and 16 that are exposed to the bore 14. That is, in response to the open and close actions of valve member 11 relative to the passage of valve seat 12, the fluid connection between first and second ports 15 and 16 is established and blocked respectively.

As is mentioned hereinabove, the left valve 2 is of a normally closed type. Thus, valve member (or valve ball) 11 is biased by a spring 17 in a direction to close the passage of valve seat 12. While, the right valve 2 is of a normally open type, and thus valve member 11 is biased by a spring 17 in a direction to open the passage of valve seat 12.

Referring to Figs. 3 and 4, there is clearly shown the common yoke 3 in a perspective manner. Figs. 3 and 4 show front and rear views of yoke 3, respectively.

As is understood from Fig. 3, yoke 3 has a generally rectangular parallelepiped shape, that comprises upper and lower walls 18 and 20 and side walls (no numerals) each extending between upper and lower walls 18 and 20. That is, yoke 3 has a rectangular cross section when cut in an imaginary plane perpendicular to a longitudinal axis of the yoke 3.

Axially opposed ends of yoke 3 are opened, which are denoted by numerals 31 and 31 in the drawings.

As is seen from Fig. 3, upper wall 18 is formed at a middle portion thereof with a longitudinally extending slit 19. As will

become apparent as the description proceeds, the yoke 3 is a device that creates outside magnetic paths. For this purpose, yoke 3 is constructed of a magnetic metal.

As is seen from Figs. 1 and 5, within yoke 3, four pairs of electromagnetic valves 2 are abreast arranged in order in such a manner that the paired solenoid coils 4 of each pair of valves 2 face each other with respect to an imaginary plane that extends along the longitudinal axis of yoke 3. More specifically, the paired solenoid coils 4 of each pair of valves 2 are arranged having slit 19 placed therebetween.

As is seen from Fig. 5, when it is intended to assemble unit 100, the paired valves 2 are slid into yoke 3 from both open ends 31 of the same. In the illustrated embodiment, two pairs are led into yoke 3 from the right open end 31, and the other two pairs are led into yoke 3 from the left open end 31.

As is seen from Fig. 1, upon proper arrangement of valves 2 in yoke 3, rectangular projections 30 of the paired solenoid coils 4 of the valves 2 are neatly put in and projected upward from slit 19. Terminal pins 8 of solenoid coils 4 are thus projected upward as shown.

As is best seen from Figs. 1, 2 and 3, upper wall 18 of yoke 3 is formed with eight circular openings 21 and also lower wall 20 of yoke 3 is formed with eight circular openings 22 that are aligned with the corresponding openings 21 to constitute eight pairs of aligned openings 21 and 22.

As is understood from Figs. 1 and 2, each pair of the aligned openings 21 and 22 are arranged to install in yoke 3 the valve function part 5 of the corresponding electromagnetic valve 2.

As is seen from Fig. 2, rectangular projection 30 of each solenoid coil 4, that slidably contacts the edge of slit 19, can serve as a positioner for positioning the bobbin 6 relative to the aligned openings 21 and 22.

That is, as is seen from Fig. 5, each paired valves 2 can slide into desired positions of yoke 3 by sliding the paired projections 30 in and along slit 19 of yoke 3.

As is seen from Figs. 3 and 4, lower wall 20 of yoke 3 is formed at a center area thereof with a circular opening 23 through which a bolt (not shown) passes to secure yoke 3 to housing 13. As is seen from Fig. 3, provision of slit 19 of yoke 3 facilitates the work for turning the bolt.

Furthermore, lower wall 20 is formed at each side area with two parallel slits 24 that define therebetween a longitudinally extending strip 25. The strips 25 are slightly bent outward from yoke 3, so that upon mounting of yoke 3 on housing 13, the strips 25 are resiliently pressed against housing 13 thereby to assure a tight connection of yoke 3 to housing 13.

As is best seen from Fig. 1, upon proper assembly of electromagnetic valve unit 100, all of terminal pins 8 of the unit are positioned at the upper side of yoke 3. Thus, when a control board (not shown) is brought onto the upper side of yoke 3, the terminal pins 8 can be automatically inserted into corresponding terminal openings provided in the control board thereby achieving an electric connection between the valve unit 100 and the control board. That is, the terminal openings are shaped to easily receive the terminal pins 8 and constructed to grasp the pins 8 when the control board is properly received on the upper side of the yoke 3.

In the following, advantages of electromagnetic valve unit 100 will be briefly described in the following.

First, as has been just mentioned hereinabove, upon putting of a control board onto the unit 100, the electric connection between the unit 100 and the control board is automatically and instantly achieved. That is, there is no need of using longer wiring for such connection, unlike in the case of the afore-mentioned publication 6-32862.

Second, mounting of the plurality of electromagnetic valves 2 in yoke 3 is easily carried out because valves 2 can be inserted into yoke 3 from both open ends 31 of yoke 3. During insertion of valves 2, the rectangular projections 30 of each paired valves 2 slide along slit 19 and thus serve as a guide means for properly positioning the paired valves 2 to their proper positions in yoke 3.

Third, because of provision of the longitudinally extending strips 25 that are slightly bent outward from yoke 3, yoke 3 can be resiliently pressed against housing 13 when connected to housing 13 through the connecting bolt (not shown). That is, undesired play of yoke 3 can be suppressed or at least minimized. The resiliency possessed strips 25 are easily provided by only providing yoke 3 with parallel slits 24. That is, the resilient pressing of yoke 3 to housing 13 is made without using separate spring member, which brings about a lower cost production of valve unit 100.

Fourth, each resiliency possessed strip 25 functions to disrupt the magnetic paths that are produced by the paired solenoid coils 4 that face each other having the two slits 24 put therebetween. Thus, undesired interference of magnetic flux between the paired solenoid coils 4 is suppressed or at least minimized, and thus, the valve performance of each electromagnetic valve 2 is improved.

Fifth, since the four pairs of valves 2 are abreast installed in yoke 3 in order, the valves 2 (more specifically, the solenoid coils 4 of the valves 2) can share the same magnetic path area on yoke 3 with one another. Thus, the magnetic path resistance can be lowered without increasing the thickness of yoke 3.

In the above-mentioned first embodiment 100, four pairs of electromagnetic valves 2 are installed in yoke 3. If the length of yoke 3 is increased, more than four pairs can be installed.

Referring to Figs. 6 to 8, particularly Fig. 8, there is shown

an electromagnetic valve unit 200 that is a second embodiment of the present invention.

Since the unit 200 is similar to the unit 100 of the aforementioned first embodiment, only parts or portions that are different from those of the unit 100 will be described in detail in the following.

As is understood from Fig. 6, in this second embodiment 200, the common yoke 103 is much simpler than yoke 3 of the first embodiment 100.

That is, as is seen from Fig. 7, yoke 103 has no means or construction that corresponds to the longitudinally extending strips 25 (see Fig. 4) employed in the first embodiment 100.

Thus, when it is intended to mount yoke 103 onto housing 13 (see Fig. 2), a separate spring member (not shown) has to be put between yoke 103 and housing 13 so that yoke 103 can be resiliently pressed against housing 13.

Since the basic structure of valve unit 200 is substantially identical to that of valve unit 100 of the first embodiment, substantially same advantages as those of the valve unit 100 except the third and fourth advantages are also obtained in the valve unit 200 of the second embodiment.

In addition to the advantages just mentioned, the valve unit 200 of the second embodiment has the following advantage.

That is, since lower wall 20 of yoke 103 has no structure corresponding to the longitudinally extending strips 25 employed in the first embodiment 100, the magnetic paths produced by the paired solenoid coils 4 can constitute continuous paths at lower wall 20.

Accordingly, as is seen from Figs. 6 and 7, the magnetic fluxes of solenoid coils 4 installed in yoke 103 are forced to largely extend to a laterally center area of lower wall 20, which means an increase in the magnetic path section that is practically used by each valve 2 and thus the magnetic path

resistance is lowered. Thus, the thickness of the common yoke 103 can be further reduced.

In the following, modifications of the invention will be described.

In the above-mentioned two embodiments 100 and 200, common yoke 3 or 103 that has both ends 31 opened is used. In such yoke 3 or 103, production is easily carried out with press working applied to a metal plate. If desired, a common yoke of a type having only one end opened may be used in the present invention.

Furthermore, in the present invention, it is not always necessary to arrange electromagnetic valves 2 in such a way that these valves 2 are installed in yoke 3 or 103 forming several pairs of them entirely along the longitudinal axis of yoke 3 or 103. However, if desired, single valve or valves 2 may be arranged in the row of the paired valves 2.

In the disclosed first and second embodiments, electromagnetic valve units 100 and 200 are described as being applied to an automotive antilock brake system for controlling opening/closing of a fluid passage of the system. Of course, the units 100 and 200 may be applied to other systems that need controlling opening/closing of a fluid passage.

Referring to Fig. 9, there is schematically shown an antilock brake system (ABS) for a wheeled motor vehicle, to which the electromagnetic valve unit 100 or 200 of the invention is practically applied. As shown, the unit 100 or 200 is arranged in a fluid line 50 that extends from a master cylinder 52 of a brake pedal 54 to brake cylinders 56 of road wheels 58 (only one is shown).

The entire contents of Japanese Patent Application 2003-147182 filed May 26, 2003 are incorporated herein by reference.

Although the invention has been described above with reference to the embodiment of the invention, the invention is

not limited to such embodiment as described above. Various modifications and variations of such embodiment may be carried out by those skilled in the art, in light of the above description.

5